#15

To: N. HERKAMP
Patent Attorney

☒ H17. Evendale ☐ 16004. Lynn

GE Aircraft Engines
Invention Disclosure
General Electric Company

For Legal Operation Use

Docket Number 13DV-1214-2

Date Opened May 14, 1994

By Mani Feli

MAY 13

Instructions

1. Using the outline given below, describe the invention fully and completely. Use as many or as few sheets as necessary for an adequate disclosure.

   A. **TITLE.** Please provide a short title of the invention.

   B. **PRODUCT.** Indicate the product line(s) to which the invention pertains (including engine designation(s) where appropriate).

   C. **BACKGROUND.** Describe the prior art (such as patents or publications) including limitations and/or problems existing therein which led to the invention and attach a copy of such prior art.

   D. **DESCRIPTION AND OPERATION.** Describe the basic structure and operation of the invention, with parts referenced by numbers on attached illustration(s) preferably no larger than 8 1/2 x11.

   E. **ADVANTAGES AND NEW FEATURES.** List the advantages and new features of the invention not found in the prior art.

   F. **ALTERNATIVES.** Describe and illustrate alternative forms of the invention.

   G. **EXECUTION OF DISCLOSURE.** Using the format illustrated below,

   EACH INVENTOR: Must **Sign and Date Each** page of the disclosure and **Each** sheet of any illustrations; and

   TWO WITNESSES: Must read, understand and **Sign and Date Each** page of the disclosure and **Each** sheet of any illustrations.

Inventor's Signature	Date	Witnessed, read, understood and signed by	Date
[signature]	4/25/94	[signature]	4/29/94
		[signature]	5/2/94
		[signature]	5/12/94

2. Send **Original and Eight (8) Copies** of the Invention Disclosure and any attached illustrations to the appropriate patent attorney.

3. **Print or Type**	Inventor	Inventor	Inventor
Full Name	S.R. MANNAVA		
Social Security Number	061-38-7041		
Mail Drop	D83		
Telephone Number	3-9416		
Department	M&QTD		

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N. Herkamp Patent Attorney		Docket Number
☒ H17, Evendale ☐ 16004, Lynn		Date Opened
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Inventor's Signature	Date	Witnessed, read, understood and signed by	Date
Herbert Halila	4/22/94	Ralph Jones	5/2/94
		[signature]	5/2/94
		W.D. Herkamp	5/12/94

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3. **Print or Type**	Inventor	Inventor	Inventor
Full Name	HERBERT HALILA		
Social Security Number	130-32-2354		
Mail Drop	X412		
Telephone Number	~~(513) 552-4385~~	243 2844 2944	
Department	FAN & COMPR. AIRFOILS CENTER OF EXCELLENCE		

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4/26/94 #15

This note is included for clarification purposes on charging practices for H. Halia connected with the Laser Shock Peening Invention .

H. Halia's time was allocated over the following component numbers during the time frame referenced on the Invention Disclosure form:

5339	CFM56
5252	LM2500
5250	CF6 Fan
5253	CF6 HPC
5392	WCFB
5354	F101/F110 Fan
5338	F101/F110 HPC

As a result, cost were allocated over numerous programs including military contracts. Due to the extent of the alloaction base however, it would not be feasable to identify specific contracts impacted.

The component numbers indicated on the Invention Disclosure form are an indication of what specific programs were involved in the actual performance of work, not an indication of cost charging.

S. Behrends
Airfoils COE Finance

To:	GE Aircraft Engines Invention Disclosure	For Legal Operation Use
N. HERKAMP Patent Attorney	General Electric Company	Docket Number 13 DV 12,142
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Inventor's Signature	Date	Witnessed, read, understood and signed by	Date
J.E. Rhoda	5-2-94		5/2/94
		James D. Drenga	5/2/94
		M. E. Herkamp	5/12/94

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3. **Print or Type**	Inventor	Inventor	Inventor
Full Name	J.E. Rhoda		
Social Security Number	333-32-3837		
Mail Drop	J40		
Telephone Number	3-3338		
Department	CHIEF Engi office		

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Inventor's Signature	Date	Witnessed, read, understood and signed by	Date
Larry Jacobs	4/28/94	Clifton J. Richards	4/28/94
		J. Potriche	4/28/94
		W. D. Herkamp	5/12/94

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3. **Print or Type**	Inventor	Inventor	Inventor
Full Name	L. JACOBS		
Social Security Number	278-38-3474		
Mail Drop	S20		
Telephone Number	~~552-5157~~ 293 3589		
Department	M&IPEO		

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Inventor's Signature	Date	Witnessed, read, understood and signed by	Date
E. A. Rainous	5/10/94	[signature]	5-11-94
		A. J. Pitkoski	5-11-94
		M. D. Herkamp	5/12/94

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3. **Print or Type**	Inventor	Inventor	Inventor
Full Name	Edward A. Rainous		
Social Security Number	303-66-5506		
Mail Drop	520		
Telephone Number	552-5566		
Department	M&IPEO		

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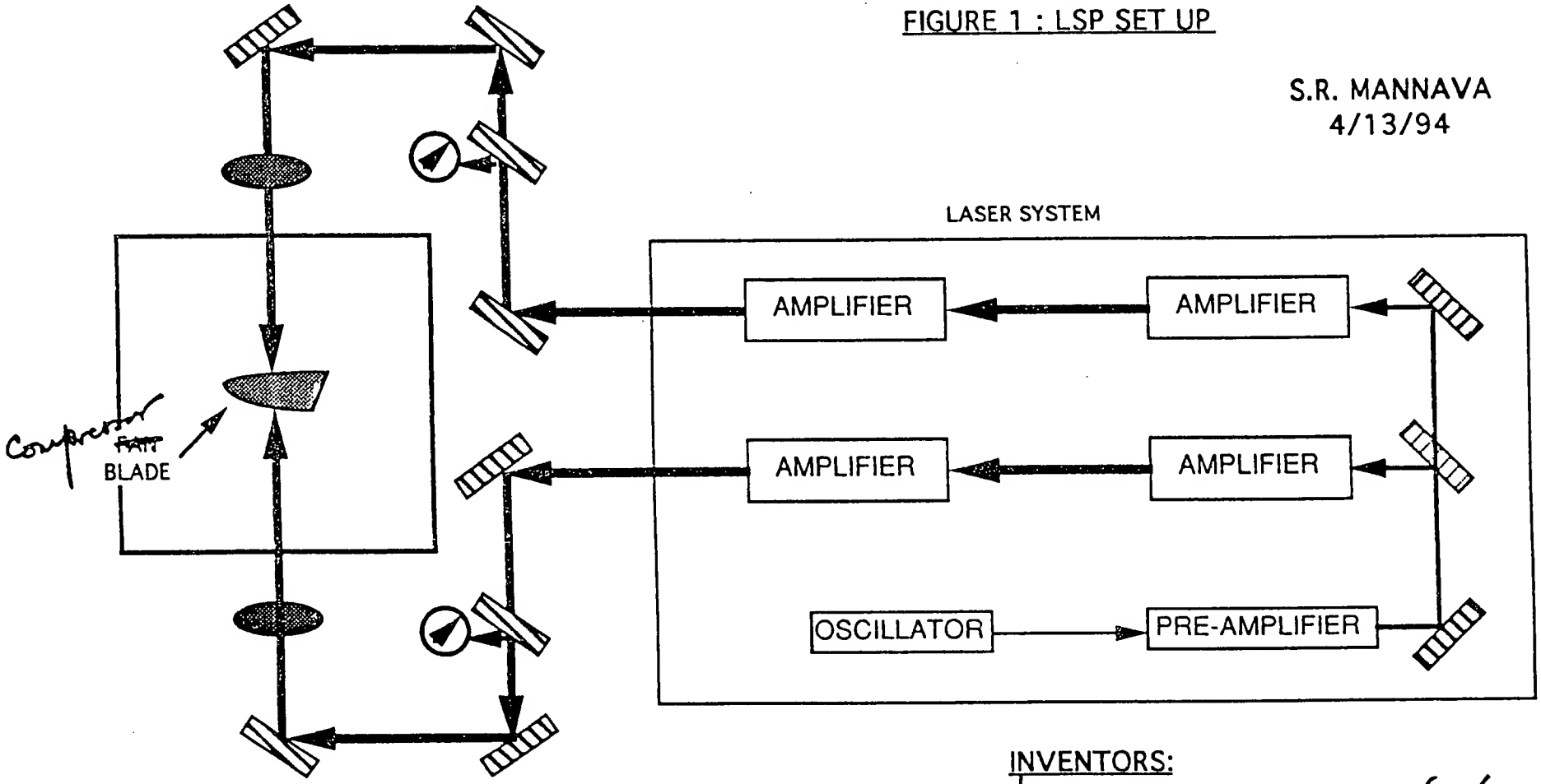
INVENTION DISCLOSURE BRIEF - ENHANCED COMPRESSOR BLADE FOR AIRFCRAFT ENGINES

FIGURE 1 : LSP SET UP

S.R. MANNAVA
4/13/94



INVENTORS:

4/25/94

4-25-94

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4/25/94

4/25/94

WITNESSES:

4/25/94

#15

4/13/94

Invention Disclosure Brief
Enhanced Compressor blades for Aircraft Engines

Abstract:
High Pressure compressor blades are susceptible to Foreign Object Damage (FOD). FOD causes nicks and tears in leading and trailing edges of airfoils. These nicks and tears become the source of high stress concentrations and severely limit the life of these blades in High Cycle Fatigue (HCF). Severe FOD damage may also result in a loss of engine due to release of failed blade.

The present solution to this problem is to design for stress concentration margins on the airfoil edges. In some cases a solution is to manage the dynamics of the blade by using dampers. Dampers are expensive and may not protect blades from very severe FODs.

This invention is about an alternate solution to the FOD problem. Compressor blades can be Laser Shock Peened (LSP) to impart deep compressive layers at selective locations on the blade without causing any surface damage. These compressive layers will increase the HCF strength of the blade in the presence of nicks and tears to a higher value perhaps depending on the conditions equal to base metal strength which ensures design life.
The concept is equally valid to new or repaired compressor blades. Selected locations on the blade can be LSPed and the resulting effects can be taken in to account in the design.

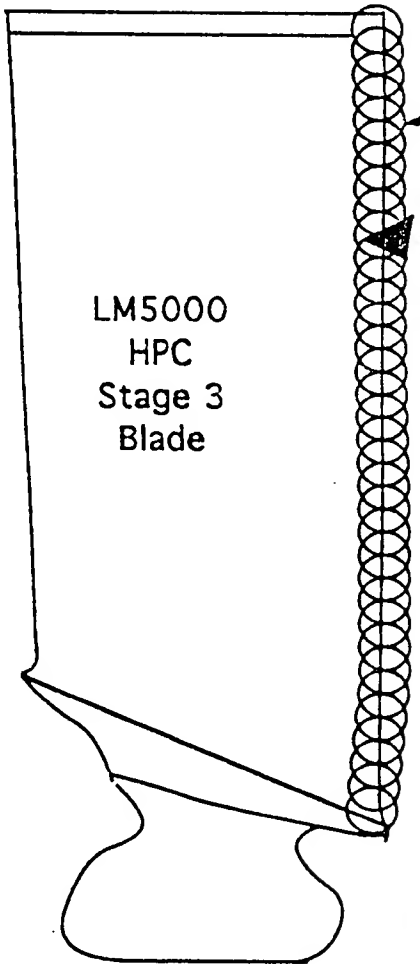
The concept has been demonstrated. The entire leading edge of LM5000 Fan blade has been LSPed and HCF tested in flex mode. Results show the HCF strength in the presence of simulated severe FOD damage is approximately equal to the base line value of undamaged blades.

Figure 1 shows LSP setup used for LM5000 compressor blade demonstration. A laser beam is split into two, amplified in several stages and are focused on either side of fan blade. Both sides of the blade are to be treated simultaneously to control blade distortion. The blade is traversed to treat the required area of the blade. Figure 2 shows HCF test results for flex mode. After the blade was LSPed it was nicked and tested. Failure stress values were recorded for runout conditions. A strain gage installed near nicked location was used to monitor the blade vibrational frequency.

INVENTORS:		WITNESSES	
[signature]	4/25/94	[signature]	4/28/94
[signature]	4-25-94	[signature]	4/28/94
Herbert Halila	4-25-94	[signature]	5/12/94
Larry Jacobs	4-25-94		
E. A. Raison	4/25/94		

INVENTION DISCLOSURE BRIEF - ENHANCED COMPRESSOR BLADE FOR AIRFCRAFT ENGINES

FIGURE 2: TEST RESULTS



LSP area on the Leading Edge of the Blade

Nick after LSP

HIGH CYCLE FATIGUE TEST RESULTS

BASE LINE - NO NICKS	80 KSI
BASE LINE & NICKS (SIMULATED FOD)	15 KSI
LSP & NICK (SIMULATED FOD)	50 KSI

WITNESSES:

Stephen Allen 4/25/94

INVENTORS:

4/25/94

4-25-94

4/25/94

4/25/94

4/25/94